3 Loops and branches

The programs in the two previous chapters consist of a number of instructions which are executed one by one, from start to finish.

However, there are a number of other ways a program can proceed:

- **Repeating a set of instructions (called loops)**
- **Doing one set of instructions or another (called IF statements)**
- **Jumping from one line of your program to another**

Repeating instructions (loops)

The DO...UNTIL and WHILE...ENDWH commands are *structures* - they don't actually do anything to your data, but control the order in which other commands are executed:

- DO...UNTIL repeats a set of instructions until a certain condition is true.
- WHILE...ENDWH repeats a set of instructions so long as a certain condition is true.

There is a test *condition* at the end of the DO...UNTIL loop, and at the beginning of the WHILE...ENDWH loop.

DO...UNTIL

```
PROC test:
  LOCAL a%
  a%=10
  DO
    PRINT "A=";a%
    a%=a%-1
  UNTIL a%=0
  PRINT "Finished"
  GET
ENDP
```

The instruction `DO` says to OPL:

"Execute all the following instructions until an UNTIL is reached. If the condition following UNTIL is not met, repeat the same set of instructions until it is."

The first time through the loop, `a%`=10. 1 is subtracted from `a%`, so that `a%` is 9 when the UNTIL statement is reached. Since `a%` isn't zero yet, the program returns to DO and the loop is repeated.

`a%` goes down to 8, and again it fails the UNTIL condition. The loop therefore repeats 10 times until `a%` does equal zero.

When `a%` equals zero, the program continues with the instructions after UNTIL.

The statements in a DO...UNTIL loop are always executed at least once.

WHILE...ENDWH

```
PROC test2:
  LOCAL a%
  a%=10
  WHILE a%>0
    PRINT "A=";a%
    a%=a%-1
  ENDWH
  PRINT "Finished"
  GET
ENDP
```

The instructions between the WHILE and ENDWH statements are executed only if the condition following the WHILE is true - in this case if `a%` is greater than 0.

Initially, a%=10 and so A=10 is displayed on the screen. a% is then reduced to 9. a% is still greater than zero, so A=9 is displayed. This continues until A=1 is displayed. a% is then reduced to zero, and so Finished is displayed.

Unlike DO...UNTIL, it's possible for the instructions between WHILE and ENDWH not to be executed at all.

Example using WHILE...ENDWH

```
PROC newkey:
   WHILE KEY :ENDWH
   PRINT "Press a new key."
ENDP
```

This procedure ignores any keys which may already have been typed, then waits for a new keypress.

KEY returns the value of a key that was pressed, or 0 if no key has been pressed. WHILE KEY :ENDWH reads any keys previously pressed, one by one, until they have all been read and KEY returns zero.

CHOOSING BETWEEN INSTRUCTIONS

In a program, you might have several possible cases (x% may be 1, or it may be 2, or 3...) and want to do something different for each one (if it's 1, do this, but if it's 2, do that...). You can do this with the IF...ENDIF structure:

```
IF condition1
   do these statements
ELSEIF condition2
   do these statements
ELSEIF condition3
   do these statements
   .
   .
ELSE
   do these statements
ENDIF
```

These lines would do **either**

- the statements following the IF line (if *condition1* is met)

or

- the statements following one of the ELSEIF lines (if one of *condition2*, *condition3*... is met)

or

- the statements following the ELSE line (if none of *condition1*, *condition2*, *condition3*... have been met).

and then continue with the statements after the ENDIF.

You can cater for as many cases as you like with ELSEIF statements. You don't have to have any ELSEIFs. There may be either one ELSE statement or none; you do not specify conditions for the ELSE statement.

Every IF in your program must be matched by an ENDIF - otherwise you'll see an error message when you try to translate the module. The structure must start with an IF and end with an ENDIF.

"Nesting" loops - the 'Too complex' message

You can have up to eight DO...UNTIL, WHILE...ENDWH and/or IF...ENDIF structures nested within each other. If you nest them any deeper, a 'Too complex' error message will be displayed.

Example using IF

```
PROC zcode:
  LOCAL g%
  PRINT "Are you going to press Z?"
  g%=GET
  IF g%=%Z OR g%=%z
    PRINT "Yes!"
  ELSE
    PRINT "No."
  ENDIF
  PAUSE 60
ENDP
```

% operator

The program checks character codes with the `%` operator. `%a` returns the code of `a`, `%Z` the code of `Z` and so on. Using `%A` is entirely equivalent to using 65, the actual code for `A`, but it saves you having to look it up, and it makes your program easier to follow.

Be careful not to confuse character codes like these with integer variables.

OR operator

OR lets you check for either of two conditions. OR is an example of a *logical operator*. There is more about logical operators later in this chapter.

Example using DO...UNTIL and IF

```
PROC testny:
  DO
    g$=UPPER$(GET$)
  UNTIL g$="N" OR g$="Y"      REM wait for a Y or N
  IF g$="N"                   REM was it an N?
    ... REM 'N' pressed
  ELSE                        REM must have been a Y
    ... REM 'Y' pressed
  ENDIF
ENDP
```

This procedure checks for a 'Y' or 'N' keypress. You'd put your own code in the IF statement, where `...` has been used.

Arguments to functions

Some functions, as with commands like PRINT and PAUSE, require you to give a value or values. These values are called *arguments*. The UPPER$ function needs you to specify a string argument, and returns the same string but with all letters in upper case. For example, `UPPER("12.+aBcDeF")` returns `12.+ABCDEF`.

Functions as arguments to other functions

Since GET$ returns a string, you can use this as the argument for UPPER$. `UPPER$(GET$)` waits for you to press a key, because of the GET$; the UPPER$ takes the string returned and, if it's a letter, returns it in upper case. This means that you can check for `Y` without having to check for `y` as well.

'True' and 'False'

The test condition used with DO...UNTIL, WHILE...ENDWH and IF...ENDIF can be any expression, and may include any valid combination of operators and functions. Examples:

Condition	*Meaning*
`x=21`	does the value of `x` equal 21? (Note - as this is a test condition, it does **not** assign `x` the value 21)
`a%<>b%`	is the value of `a%` not equal to the value of `b%`?
`x%=(y%+z%)`	is the value of `x%` equal to the value of `y%+z%`? (does not assign the value `y%+z%` to `x%`).

The expressions actually return a *logical value* - that is, a value meaning either 'True' or 'False'. Any non-zero value is considered 'True' (to return a 'True' value, OPL uses -1), while zero means 'False'. So if `a%` is 6 and `b%` is 7, the expression `a%>b%` will return a zero value, since `a%` is **not** greater than `b%`.

Î Constants for 'True' and 'False' are given in Const.oph. See the 'Calling Procedures' chapter for details of how to use this file and see Appendix E for a listing of it.

These are the conditional operators:

<	less than	<=	less than or equal to
>	greater than	>=	greater than or equal to
=	equal to	<>	not equal to

Logical operators

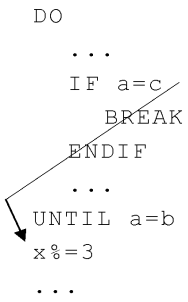
The operators AND, OR and NOT allow you to combine or change test conditions. This table shows their effects. (`c1` and `c2` represent conditions.)

Example	*Result*	*Integer returned*
`c1 AND c2`	True if both `c1` and `c2` are true	-1
	False if either `c1` or `c2` are false	0
`c1 OR c2`	True if either `c1` or `c2` is true	-1
	False if both `c1` and `c2` are false	0
`NOT c1`	True if `c1` is false	-1
	False if `c1` is true	0

However, AND, OR and NOT become *bitwise operators* - something very different from logical operators - **when used exclusively with integer or long integer values**. If you use `IF A% AND B%`, the AND acts as a bitwise operator, and you may not get the expected result. You would have to rewrite this as `IF A%<>0 AND B%<>0`. (Operators, including bitwise operators, are discussed further in Appendix B.)

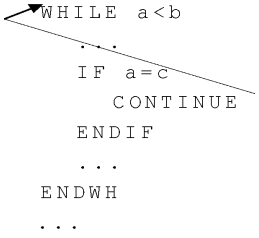
Jumping out of a loop: BREAK

The BREAK command jumps out of a DO...UNTIL or WHILE...ENDWH structure. The line after the UNTIL or ENDWH statement is executed, and the lines following are then executed as normal. For example:



Jumping to the test condition: CONTINUE

The CONTINUE command jumps from the middle of a loop to its test condition. The test condition is either the UNTIL line of a DO...UNTIL loop or the WHILE line of a WHILE...ENDWH loop. For example:



Jumping to a ‘label’: GOTO

The GOTO command jumps to a specified *label*. The label can be anywhere in the same procedure (after any LOCAL or GLOBAL variable declarations). In this example, when the program reaches the GOTO statement, it jumps to the label `exit::`, and continues with the statement after it.

The two PRINT statements are missed out.

Labels themselves **must** end in a double colon. This is optional in the GOTO statement - both `GOTO exit::` and `GOTO exit` are OK.

The jump to the label always happens - it is not conditional.

Don’t use GOTOs instead of DO...UNTIL or WHILE...ENDWH, as they make procedures difficult to understand.

Vectoring to a label: VECTOR/ENDV

VECTOR jumps to one of a list of labels, according to the value in an integer variable. The list is terminated by the ENDV statement. For example:

```
  VECTOR p%
    FUNCA,FUNCX
    FUNCR
  ENDV
  PRINT "p% was not 1/2/3" :GET :STOP
FUNCA::
  PRINT "p% was 1" :GET :STOP
FUNCX::
  PRINT "p% was 2" :GET :STOP
FUNCR::
  PRINT "p% was 3" :GET :STOP
```

Here, if `p%` is 1, VECTOR jumps to the label `FUNCA::`. If it is 2, it jumps to `FUNCX::`, and if 3, `FUNCR::`. If `p%` is any other value, the program continues with the statement after the `ENDV` statement.

The list of labels may spread over several lines, as in this example, with a comma separating labels in any one line but no comma at the end of each line. Again, you can write each label in the list with a double colon, if you like.

VECTOR...ENDV can sometimes save you from having to write very long IF...ENDIF structures, with ELSEIF used many times.

Stopping a running program

This example introduces the STOP command. This stops a running program completely, just as if the end of the program had been reached. In a module with a **single** procedure, STOP has the same effect as using GOTO to jump to a label above the final ENDP.

UNTIL 0, WHILE 1

Zero and non-zero are logical values meaning 'False' and 'True' respectively. `UNTIL 0` and `WHILE 1` therefore mean 'do forever', since the condition 0 is never 'True' and the condition 1 is always 'True'. Use loops with these conditions when you need to check the real condition somewhere in the middle of the loop. When the real condition is met, you can BREAK out of the loop.

For example:

```
PROC test:
  WHILE 1
    ... REM some other lines here
    IF KEY :BREAK :ENDIF
    ... REM some other lines here
  ENDWH
ENDP
```

This example uses the KEY command. KEY returns 0 if no key has been pressed. When a key is pressed, KEY returns a non-zero value which counts as 'True', and the BREAK is executed.

SUMMARY

```
DO
  statements
UNTIL condition

WHILE condition
  statements
ENDWH

IF condition
  statements
[ELSEIF condition
  statements]
[ELSE
  statements]
ENDIF

VECTOR int%
  label1, label2
  label3...
ENDV
...
label1::
...
label2::
...
label3::
...
```

`GOTO label` jumps to `label::`

`BREAK` goes to the first line after the end of the loop - the line following the UNTIL or ENDWH line.

`CONTINUE` goes to the test condition of the loop - the UNTIL or the WHILE line.

`STOP` stops a running program completely.